Documentation Needs and Explicit Criteria for Progressing to Level 3 Studies

A Level 2 report should document reconnaissance efforts and findings, possibly integrating them with Level 1 information in a single revised report. Major sections need to identify specific recreation opportunities, identify flow-dependent attributes, identify rough flow ranges (if possible), and assess whether project operations are likely to have impacts on those opportunities.

Agency and stakeholder review is important, and may be implemented differently in traditional, alternative, or integrated planning processes. Earlier reporting allows more time to plan additional work (if needed) or integrate findings with work from other resource areas.

The report should include explicit decisions about whether additional study is necessary for each opportunity and reach. The utility and consultants typically outline the issues in the report, but review by agencies and stakeholders (via working groups) can make those decisions more collaborative, or identify disputes.

Deciding whether to launch more intensive Level 3 studies is the critical study output; this depends on answers to the same questions discussed for the adequacy of Level 1 efforts. For opportunities where users are relatively insensitive to flows, or where project effects do not appear substantial, Level 2 information is likely to be sufficient. However, if project operations are likely to have direct and noticeable effects and flow regime changes are possible, greater precision may be necessary.

Intensive Study Options (Level 3)

For opportunities that are obviously flow-dependent and where precise information about flow needs or project effects is needed, more intensive effort is recommended. Several options for different types of recreation studies are described below.

Multiple Flow Reconnaissance Assessments

Objective
Improve precision of estimated flow ranges for recreation opportunities by assessing multiple flows. Generally applicable to boating, fishing, tubing, or swimming on reaches with logistical complications that prevent evaluations associated with controlled flow studies (see additional issues below).

Typical approach
Similar to single flow assessments, these differ by assessing multiple flows. Participation by recreation users is typically limited (see controlled flow studies below), but may be important. Quantitative ratings (by panels or experts) are commonly made for all relevant opportunities and conditions. Photos of key sites and conditions, along with rough measurements of key features (e.g., pools, current speed) may be useful, particularly for non-boating and fishing conditions. Qualitative notes or focus group discussions after are used to summarize opinions about the feasibility or quality of different types of opportunities at different flows.

Product
Summary of reconnaissance efforts and findings. A list of participants, evaluation results, photos, measurements, and discussion notes may be provided in appendices. Usually presented in a report that is supplemental to Phase 1 and 2 reports.

Responsibilities
As with other assessments, utilities (or their consultants) have primary responsibility, but agencies and stakeholders commonly participate in fieldwork and review evaluation forms.

Additional issues
Multiple-flow assessments that rely on expert judgments usually occur when logistical constraints make it difficult to assemble or maintain an evaluation panel. Example problems might include the inability to control flows (necessitating opportunistic fieldwork when natural flows are close to target levels) or difficult access to the river reaches. For some opportunities, potential participants (e.g., tubers or swimmers) may not be particularly sensitive to flow changes (or able to express preferences for specific flows), so it may be efficient and effective to have experts evaluate key conditions (which assumes the need to carefully document conditions and assumptions).

Multiple-flow assessments often focus on more than one recreation activity, which may present logistical challenges. Given trade-offs between the number of sites that can be assessed and the quality of assessments, identifying representative locations or reaches for more intensive work is critical.

Choosing the number and increments of flows is a case-by-case decision that generally depends on Phase 1 and 2 findings and requests from other resource areas (fisheries, etc.). Assessments of two to four flows are common.

Cautions & limitations
Expert judgments are often sufficient when supported with clear documentation of conditions at different flows, but user, agency, or stakeholder participation is important and powerful.

SIDEBAR

Flows and Aesthetics

Aesthetics of river environments are important in dam relicensing, particularly when reaches have waterfalls and cascades. When aesthetics are a critical attribute, studies may need to address how flows affect them.

A complete review of aesthetics literature related to flows is beyond the scope of this document. However, findings from a few studies suggest interesting generalizations. In a study from the Virgin River downstream of Zion National Park, for example, respondents were shown video footage of flows ranging from 0 to several thousand cfs (Shelby, Whittaker, & Ellingham, 1994). At low flows, small increments offered dramatic improvements in aesthetic quality; once the bottom of the channel was filled, however, there was little improvement from medium to high flows. Professional judgment curves (based on onsite reconnaissance and user interviews) for Connecticut's Shepaug River suggested similar findings (Shelby & Whittaker, 1999). In this small stream, even a 5 cfs dam release improved aesthetics, and above 50 cfs, additional water provided little aesthetic improvement.

Other studies have evaluated paired photographs (Land & Water Associates, 1992), or compared evaluations among several photographs after controlling for other scenic features such as vegetation, sky, and canyon walls (Brown and Daniel, 1991). In general, very low and very high flows were rated lower, although differences were small. Computer-manipulated images now offer opportunities to control other scenic features in photographs, so evaluations focus solely on flow elements.

Methods and analysis strategies have not been standardized in this field, but advances appear likely and should improve the ability to assess how alternative flow regimes affect aesthetics. Several study options presented in this document are applicable to aesthetics, particularly multiple flow and controlled flow assessments. Many FERC relicensing efforts have included descriptive studies of aesthetics (i.e., photo or video documentation of key reaches, rapids, or falls at different flows). But fewer studies have included an evaluative component where aesthetic qualities of different flows are compared, and these have often based evaluations on professional judgments. The literature suggests that aesthetic evaluations by trained professionals may not match those of the general public, so studies that include recreation user evaluations may be important in some situations. Comparative flow surveys are probably most relevant study choice here, and representing different flows through photographic media provides an efficient way to avoid having users observe flows on-site.

Flows may have a major impact on river aesthetics, but fewer studies have addressed this issue. Above: California's Kern River.

Small increases in flow dramatically improve aesthetics on Connecticut's Shepaug River (Left to right : 10, 60, and 200 cfs).

Flow Comparison Surveys of Experienced Users

Objective
Improve precision of estimated flow ranges for recreation opportunities by surveying experienced users. Generally applicable to boating or fishing when users have a history of use and they are "calibrated" to an existing gage.

Typical approach
Identify panel of knowledgeable users (usually boaters or anglers) and develop contact information. Develop survey instrument with sections documenting user experience and knowledge, use patterns, and evaluations of conditions and flows. Administer survey, either by mail or telephone, and code responses. Analyze data to summarize responses, with attention to disaggregating dissimilar types of users. Summarize findings in a report.

Product
Summary of methods and findings. Methods should include descriptions of panel and instrument development, as well as potential sources of error. Findings are typically presented in both tabular and graphic forms appropriate to the analysis. The findings may be presented as a report supplemental to Level 1 and 2 reports.

Responsibilities
As with other assessments, utilities (or their consultants) have primary responsibility, but agencies and stakeholders commonly review the sampling frame, survey instrument, and analysis plans. Agencies often possess lists of guides or other knowledgeable users (if there is a permit system) to help with panel development.

Additional issues
Panel development is critical for this option and depends on the availability of knowledgeable users and an existing gage to which they are calibrated. Networking may under-sample "lower profile" but knowledgeable users; networking that attempts to develop samples through multiple channels (e.g., guide lists, boating or angling stores, and launch registers) is one approach to minimizing these problems. Sufficient panel sizes are important for statistical purposes, but the "minimum" number depends on the homogeneity of users and their evaluations. Sub-group panel sizes may be important if comparisons between groups are needed.

Cautions & limitations
Assessing how well users are calibrated to a gage is important with this method. Pre-testing or pre-study interviews/focus groups should be considered to probe whether users really pay attention to a gage through the range of interest. If there is confusion in how gages are used, controlled flow studies or other options may be necessary.

Some users may not independently evaluate flows, and simply repeat "conventional wisdom" about acceptable or optimal flows for a recreation opportunity. Unfortunately, this method is limited in its ability to distinguish independent evaluations from those that are "passed down" over the years. In cases where skill and equipment advances have occurred (e.g., new types of boats or fishing techniques), this method may not be appropriate.

For angling, it may be challenging to keep evaluations of fishability (e.g., wadeability, access to fishing water) separate from evaluations of flows for the fishery (i.e., their impressions of biological needs). In these cases, controlled flow studies may be more useful. For more information on this potential confound in any fishability study, see the associated sidebar.

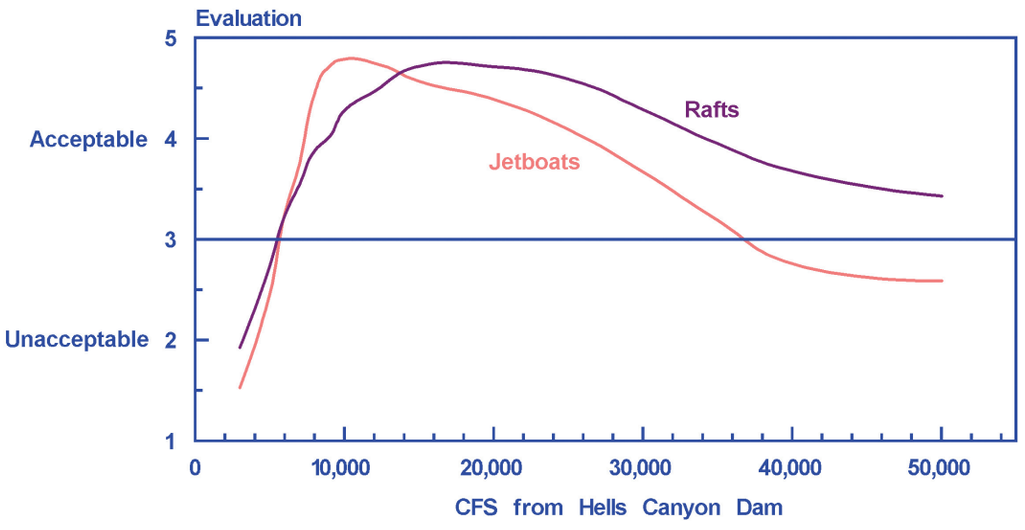
"Boat dragging" on Alaska's Gulkana River at low flows. Data from research trips at different flows supplemented boater survey information in this study for a water rights adjudication.

Far Left: Rafters pushing a boat into the Colorado River in Grand Canyon after overnight flow fluctuations left it "high and dry." Flow comparison surveys of experienced boaters helped define fluctuation tolerances.

Inset: The Snake River through Hells Canyon has similar daily flow fluctuations based on power demand. Surveys showed that rafters and jetboaters preferred fluctuations of less than 3,000 cfs per day, but could tolerate 6,000 to 9,000 cfs. Current operations fluctuate 12,000 cfs in some seasons. Inset: Consequences are greater for larger boats.

Far Right: Lava Falls in Grand Canyon at about 35,000 cfs. Experienced boaters are often knowledgeable about the flows that produce different types of recreation opportunities. Flow comparison studies draw on this accumulated knowledge.

Right: A commercial jetboat runs Wild Sheep Rapid in Hells Canyon at 9,000 cfs. Flow comparison surveys were used to develop overall flow evaluation curves for rafts and jetboats (below). Minimum flow needs were similar, but higher flows are better for rafts than jetboats.



Objective
Improve precision of estimated flow ranges for boating opportunities by having a panel of boaters evaluate several known (usually controlled) flows. Generally applicable to rivers without a gage or little history of previous use, the idea is to manipulate the independent variable – flow – which introduces a quasi-experimental format to evaluations. Assembled panels may also offer opportunities to roughly explore regional "supply" of similar rivers or "demand" for similar opportunities.

Typical approach
Level 1 and 2 information is used to determine flow range and opportunities of interest. Target flow increments are chosen and arranged for a short period of time (if possible). In some cases, the study may capitalize on natural flows instead of controlled flows. Boaters complete a pre-fieldwork survey on their experience and boating preferences, run the river at each flow, and evaluate flows and participate in a focus group after each run. After all flows have been observed, participants make overall evaluations using a "flow comparison" format. Photos and video footage of key rapids and conditions can provide useful documentation, particularly in combination with qualitative focus group notes and quantitative data from surveys. Quantitative ratings (by panels or experts) are commonly made for all relevant opportunities and conditions (see Whittaker et al. (1993) and Whittaker and Shelby (2002) for more detailed information about survey instruments and analysis options).

Products
Summary of methods and findings in a report. Methods should include descriptions of panel and instrument development. Findings typically include tables and graphs appropriate to the analysis. Appendices typically include a list of participants, focus group notes, photo gallery, and survey instruments. The methods and findings may be presented as a report supplemental to Phase 1 and 2 reports. Some utilities produce an edited video that highlights study findings with footage of key flow effects and interviews/focus group comments; these need to be coordinated and consistent with report findings.

Responsibilities
These studies are more complicated and typically require substantial participation by utilities, their consultants, agencies, and stakeholders. Utilities (or their consultants) have primary responsibility, but agencies and stakeholders also play key roles (see sidebar with more detail on these potential roles).

Additional issues
There are several important issues in conducting controlled flow studies efficiently and effectively (Shelby et al, 1998). Some of these issues become even more challenging on higher gradient rivers with little previous use (Shelby et al. 2004). It is beyond the scope of this document to provide details on these issues, but key considerations are listed below:

Study output. The relative precision of qualitative and quantitative data may vary depending upon the size of the panel and how data is analyzed. More precise "flow evaluation curves" or "optimal ranges" come from quantitative surveys of participants, but professional judgments by researchers may be sufficient if maintenance of a panel is difficult. More precise quantitative output becomes important when potential for controversy is high. Other resource studies typically generate specific incremental relationships between flows and resource values (e.g., IFIM studies), so parallel information for recreation is needed if careful assessments of trade-offs between resources are anticipate d.

Sample. Sample issues trade-off "representativeness" against potential cost or logistical complexity. More participants improve precision, but they also increase complexity and make it difficult to maintain participation through a multi-day study. Most studies use "purposive sampling," inviting participants based on their 1) skill and safety record, 2) proximity to the river, and 3) ability to evaluate a diversity of whitewater opportunities. This requires close coordination with stakeholder groups.

Flow control. This includes technical limitations of dams as well as administrative, political, and legal constraints, which should not be underestimated (Shelby et al., 2004). Technical limitations on releasing precise flows or narrow increments can be more problematic on higher gradient rivers, because small changes in flow may create substantial changes in difficulty. Lack of upstream storage may also constrain flow control (insufficient water in dry years; too much in wet years). Many studies require careful timing and contingency plans, which also may have administrative, political, or legal constraints.

Flow choice. Choosing the number and increments of flows is a case-by-case decision that generally depends on Level 1 and 2 findings and requests from other resource specialists (e.g., fisheries researchers, etc.). Three to four flows are commonly assessed in these studies.

Impacts on other resources. Timing of boating flows may be a major concern for other resources. If possible, releases should be timed to minimize adverse impacts to aquatic biota and power generation schedules, or at least to assess potential impacts (which may include biophysical benefits such as building beaches, cleaning spawning beds, introducing woody material, or removing encroaching vegetation).

Study complexity. This increases with the number of flows, length of the reach, number of participants, and types of craft or opportunities under consideration. Controlled flow studies work best when they are focused on discrete flow ranges where more precision is needed, and where boating is expected to be possible and safe. Rugged terrain associated with challenging rivers may increase the logistical challenges and safety/liability risks, which may affect panel and analysis considerations. Safety priorities may also preclude examination of flows near the high or low ends of acceptable ranges, or increase costs if additional emergency equipment or expertise is needed.

Cautions & limitations

Controlled flow studies are most useful where river segments are short, flows can be definitively controlled, river access is easy, and users are readily available (Shelby et al. 1998). These characteristics are commonly found on bypass reaches at hydropower projects. Applying this method to longer reaches without flow control is more problematic.

Controlled flow studies for boating focus on immediate effects on hydraulics, but they may not document longer-term indirect effects that may be important for boating or other recreation. These studies also may not address a diversity of flows through a season unless there are resources to examine many flows. They are better suited as a tool to identify specific flows that may be released as an augmentation for one or two opportunities.

California's Pit 5 Bypass Reach during a controlled study (1,260 cfs shown here).
The study examined six flows from 250 to 1,840 cfs. Optimal ranges started about 1,200 cfs for kayaks and 1,500 cfs for rafts.

Hells Corner rapid on the Upper Klamath River at 730 cfs (top) and 1,750 cfs (bottom) show differences between "technical" rock-dodging trips and "standard" trips with better whitewater and more route options. A commercial rafting industry has developed here because daily peaking regimes produce at least 1,500 cfs on most summer days, providing superb whitewater "action." Lower flows are under consideration in relicensing, but the boating study showed that flows less than 1,300 cfs require smaller boats with fewer passengers, which are less commercially viable.

During controlled flow boating studies, participants report boatability problems such as "stops" and "boat drags." Above: At 400 cfs on California's Kern River, "stuck" boats created "raft jams" as upstream boaters waited for rapids clear. At 800 cfs, boatability problems were rare.

SIDEBAR

Problems with "Blind" Controlled Flow Studies for Boating

When controlled flow studies for boating are proposed, the quasi-experimental nature of the effort sometimes leads agency staff or stakeholders to suggest that evaluations should be conducted "blind" (without boaters knowing which flow they are assessing). Although blind studies may increase "confidence" that evaluations are only based on the observed flow, there are several disadvantages (discussed below) that out weigh that advantage.

There may be safety concerns in not knowing flows, or the amount of change from one study flow to another, particularly on challenging rivers. Although boaters in a blind study would probably know immediately whether a subsequent flow was higher or lower, information about the magnitude of change could be crucial for deciding whether they have the skill to handle it. Boaters are accustomed to estimating how specific flow changes affect the level of challenge on other rivers; they need similar information on a study river.

Knowledge of study flows allows boaters to interpolate between flows or extrapolate beyond them for the flow comparison survey at the end of a study. If they don't know the flows they evaluated, flows between or outside the study flows cannot be evaluated.

Boaters often think in terms of cfs, and it is one of the basic metrics they use in describing a boating run (along with gradient, and the height or width of specific drops). Asking them to evaluate a reach and flow without this metric reduces their ability to do so. Just as surfers pay attention to the height of waves or skiers to the depth of snow, quantitative information is something river runners integrate into their description of what they observed. Eliminating this variable is likely to make them less systematic in their evaluations.

Boaters often have a working knowledge of flows on many rivers that may be similar to the study reach; blind studies don't allow participants to capitalize on that knowledge. For example, it may be valuable to have boaters discuss how 500 cfs on the study reach is similar to or different from 500 cfs on another reach (something they can't do if they don't know the flow).

Withholding flow information during a study may encourage participants to think the utility or researchers don't "trust" boaters. Accurate data provided to boaters as soon as it is available generally creates a greater sense of cooperation.

Blind studies are probably not necessary to alleviate concerns about "strategic bias" (respondents answer questions in line with how they think data will be used). There has been little evidence to suggest strategic biases occur in recreation studies in general, or flow studies in particular. Based on focus group discussions and analyses of study results, differences in evaluations appear to reflect skill, equipment, or type of boating preferences rather than strategic biases. In addition, participants appear to understand that results could be used to develop flow releases, but they also know that requests for higher flows generally work against the likelihood of frequent releases. It is generally in their best interest to evaluate flows accurately so they can determine the lowest flow that provides a particular recreation opportunity.

Boaters can make more informed comparisons when they know the flows during studies.

Right: California's Pit 5 bypass reach at 1,840 cfs (boaters rated six flows from 250 to 1,840 cfs).